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A Novel Approach to Patient Transfer: Multi-Fold Wheelchair cum wheeled Stretcher/Bed Integration

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Abstract: ***Efficient and safe patient transfer remains a critical challenge in healthcare settings, particularly for individuals with limited mobility or genetic disorders such as Spinal Muscular Atrophy (SMA). To address the difficulties faced by nursing staff during patient transportation and handling, this research presents the design and fabrication of a multi-fold convertible wheelchair-stretcher. The proposed system employs a chain and rod mechanism to enable seamless transformation between wheelchair and stretcher modes. When actuated, the mechanism raises the footrest to seat level while simultaneously lowering the backrest, creating a flat, stretcher-like platform. Reversing the mechanism returns the device to its wheelchair configuration. The compact, foldable design ensures adaptability for both hospital environments and in-home care, offering enhanced convenience, safety, and mobility***

Keyword: Wheelchair, DC motor, Stretcher, Chain and Rod mechanism.

I. INTRODUCTION

The advancement of assistive mobility devices plays a pivotal role in improving the quality of life for individuals with physical impairments. Among these, the need for multi-functional, cost-effective, and adaptable designs** has become increasingly urgent—especially in resource-constrained settings such as rural healthcare centers, disaster zones, and low-income communities. Traditional wheelchairs and stretchers, while essential, often demand separate investments, occupy considerable space, and lack versatility in real-time emergency scenarios.

In this context, the design and fabrication of an Electric Wheelchair Cum Stretcher using scrap materials emerges as a pragmatic and sustainable solution. By repurposing components from discarded bicycles, hospital trolleys, car seats, and electric motors, the proposed design minimizes environmental waste while significantly reducing manufacturing costs. This initiative aligns with the principles of frugal engineering and circular design economy, providing accessibility without compromising functionality.

The electrically powered conversion mechanism allows users or caregivers to seamlessly transform the device from a seated wheelchair to a fully horizontal stretcher mode, aiding in patient transfer, transport, and stabilization. Key features include motorized propulsion, reclining capabilities, and a compact structural frame, all made possible through the strategic integration of salvaged materials and minimal off-the-shelf components.

This paper aims to detail the design methodology, mechanical and electrical integration, and feasibility analysis of this innovative system. It also explores potential use cases in hospital emergency wings, ambulance fleets, railway platforms, and home-care environments, demonstrating how sustainability and innovation can converge to meet critical healthcare needs.

II. LITERATURE REVIEW

Jyothish et.al in their research proposed a dual functionality wheel chair cum stretcher. The design basically uses hydraulic height adjustment system for patient transfer. The space efficiency claimed is reduced by 50%, a lid mechanism to manage human waste. The system does not use an electric motor and has to be operated manually by a lever mechanism [1].

Peter Axelson et al. offer a comprehensive guide to wheelchair selection grounded in ANSI/RESNA standards, emphasizing the importance of aligning design choices with the user's functional requirements, living environment, and lifestyle. The guide also delves into advanced considerations such as center of gravity, caster flutter, and propulsion efficiency to support informed decision-making [2].

The integration of dual-function mobility devices has gained attention for its potential to enhance patient handling in constrained medical environments. Kumar *et al.* developed a manually operable wheelchair–cum–stretcher mechanism that emphasizes ergonomics, space efficiency, and affordability. Their design, constructed from mild steel, offers a cost-effective alternative suitable for hospitals and transit hubs, particularly in resource-limited settings [3].

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In an effort to enhance mobility solutions for individuals with physical disabilities, Pawar et al. proposed an innovative electric wheelchair cum stretcher design that integrates powered mobility with a convertible stretcher mechanism. Their work emphasizes mechanical efficiency, employing a chain drive transmission system powered by a 250W DC motor, and includes detailed structural analysis using ANSYS. The design addresses both cost-effectiveness and functional adaptability, making it suitable for hospital and industrial environments where patient transfer and manoeuvrability are critical. The estimated cost of the design proposed wheel chair is approximately ₹20,000/- [4].

In their comprehensive study, Patil et al. present a detailed review of multifunctional wheelchair–cum–bed systems, emphasizing the growing need for such devices in the care of immobile patients, particularly in hospitals and old-age homes. The paper explores various mechanical configurations that enable smooth transformation between wheelchair and bed modes, aiming to reduce caregiver strain and enhance patient comfort. Notably, the authors highlight the potential of integrating features like mini compressors and solar panels to improve usability and sustainability. Their work underscores the importance of cost-effective, space-saving designs that can be operated with minimal training, making them suitable for both institutional and home-based care environments [5]

A. Proposed System

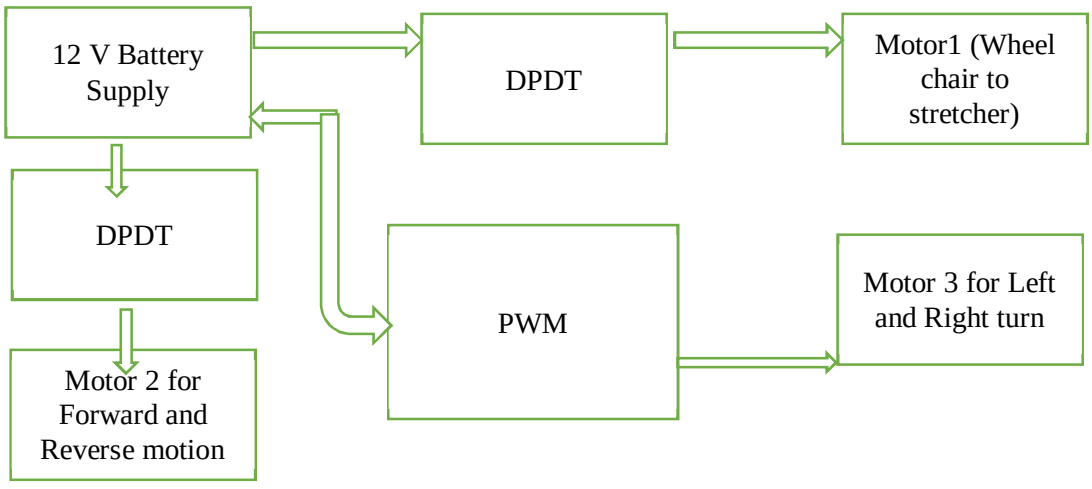
The proposed design focuses on the development of a cost-effective, convertible wheelchair–cum–bed/stretcher by utilizing recycled and scrap materials, addressing both economic feasibility and sustainability in assistive healthcare technology.

In this design, a scrap is repurposed as a compact and low-power actuator to drive the mechanical conversion between wheelchair and bed modes. The bicycle sprocket and chain assembly serves as the transmission system, efficiently transferring rotational motion from the wiper motor to the reclining and extension mechanisms. This simple drivetrain ensures mechanical advantage, while keeping fabrication straightforward and easily serviceable.

The frame is constructed using mild steel pipes and components retrieved from discarded furniture, bicycles, and hospital trolleys. This modular assembly is designed to allow the backrest and leg rest to adjust independently, enabling full transformation into a flat stretcher configuration. The mechanical links are arranged through a hinge-and-rail system, with scissor-type supports offering stability during conversion.

By harnessing low-voltage DC motors, scrap chain drives, and locally available parts, this design significantly lowers production costs and environmental impact. It is especially suited for deployment in rural clinics, home-care settings, and emergency response vehicles, where traditional powered medical equipment may be financially or logistically unviable.

B. Block Diagram



C. Technical Specifications

A) MOTOR:

12V, Brushed DC motor

Drive Mechanism: Linkage based with worm gear reduction

Typical Torque: 15 Nm

Speed: Two speed settings

B) Chain and Sprocket:

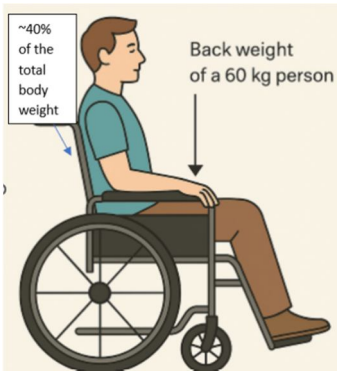
Tooth count: 30-53

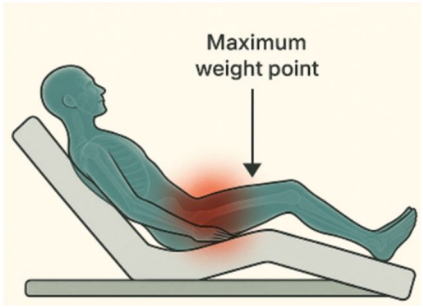
Material: Steel

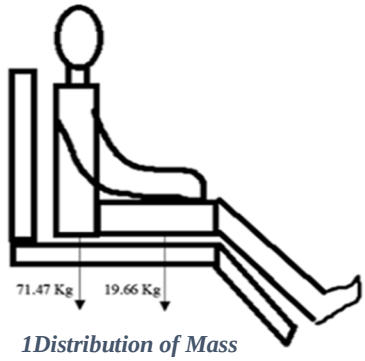
Chain type: ANSI# 410, #415

Tensile Strength: 875~2000N

The chassis is designed of mild steel suitable for a person with a weight of 60Kg. The back rest can handle a weight of approximately 15-20Kg with the available torque. The motor is controlled by a two-way switch for forward and backward movement. For turning around, a change over switch for another motor controlling the front wheels is used.







1Distribution of Mass
[4]

D. Prototype of the actual design with material used

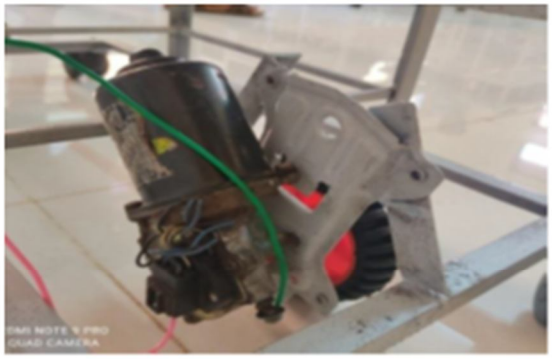


Fig.1.DC motor for Reclination

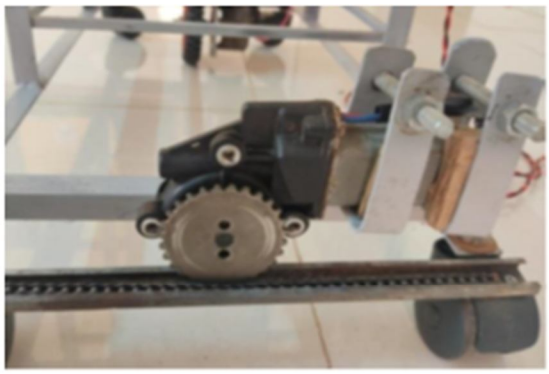


Fig. 2. Chain and sprocket assembly



Fig. 3 Chair Mode



Fig.4 Bed/ Stretcher mode

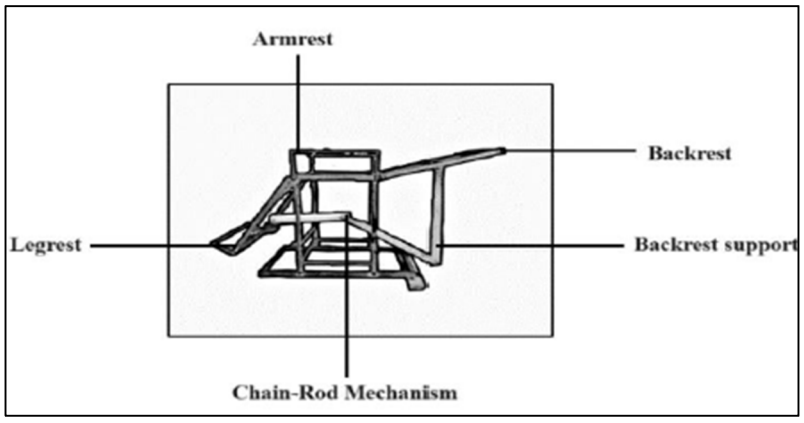


Fig.5 Schematic of the project

Cost Estimation: 80% of the material used is re-purposed to make this design economically suitable for use in rural area. However, the total bill of materials does not exceed more than ₹ 5,000/-.

III. CONCLUSION

The integration of a multi-fold wheelchair cum wheeled stretcher/bed presents a transformative step forward in the realm of rural healthcare mobility solutions.

By combining multiple patient handling devices into a single, foldable unit—designed with affordability, simplicity, and ease of use in mind—this approach directly addresses the pressing challenges of space constraints, limited medical infrastructure, and scarcity of trained caregivers often found in rural and resource-limited settings. The proposed design, which utilizes repurposed components and a mechanically efficient folding mechanism, not only offers practical functionality but also aligns with the principles of sustainable engineering. It empowers caregivers to perform patient transfers with minimal physical effort and improves the safety, dignity, and comfort of immobile individuals. In essence, this research reinforces the potential of frugal innovation and human-centered design in bridging the gap between healthcare demand and accessibility in underserved communities. Future enhancements, such as motorized actuation or smart monitoring capabilities, can further extend its utility in both pre-hospital and in-facility care scenarios.

IV. FUTURE SCOPE

The proposed design lays a strong foundation for affordable, multifunctional patient transfer systems. However, several enhancements could significantly broaden its utility, performance, and safety—especially in clinical, emergency, and rural healthcare scenarios.

1) Single Motor Drive System: Future iterations can be optimized to use a centralized motor drive mechanism, reducing the complexity of multi-motor configurations. This approach improves energy efficiency, minimizes maintenance, and simplifies the control system architecture—making the device more reliable in environments with limited technical support.

2) Joystick-Based Navigation: Integrating a joystick interface can enable effortless, user-controlled mobility. Designed with ergonomic access, the joystick can control both navigation and position adjustment (e.g., reclining and lifting), making the system intuitive for both patients and caregivers, especially those with limited dexterity.

3) Use of Biomaterials or Medical-Grade Materials: Adopting biocompatible and non-reactive materials, such as medical-grade stainless steel, antimicrobial vinyl upholstery, or eco-friendly bioplastics, can enhance patient hygiene, device longevity, and compliance with infection control standards. This is particularly critical in rural healthcare settings where sanitation resources are often limited.

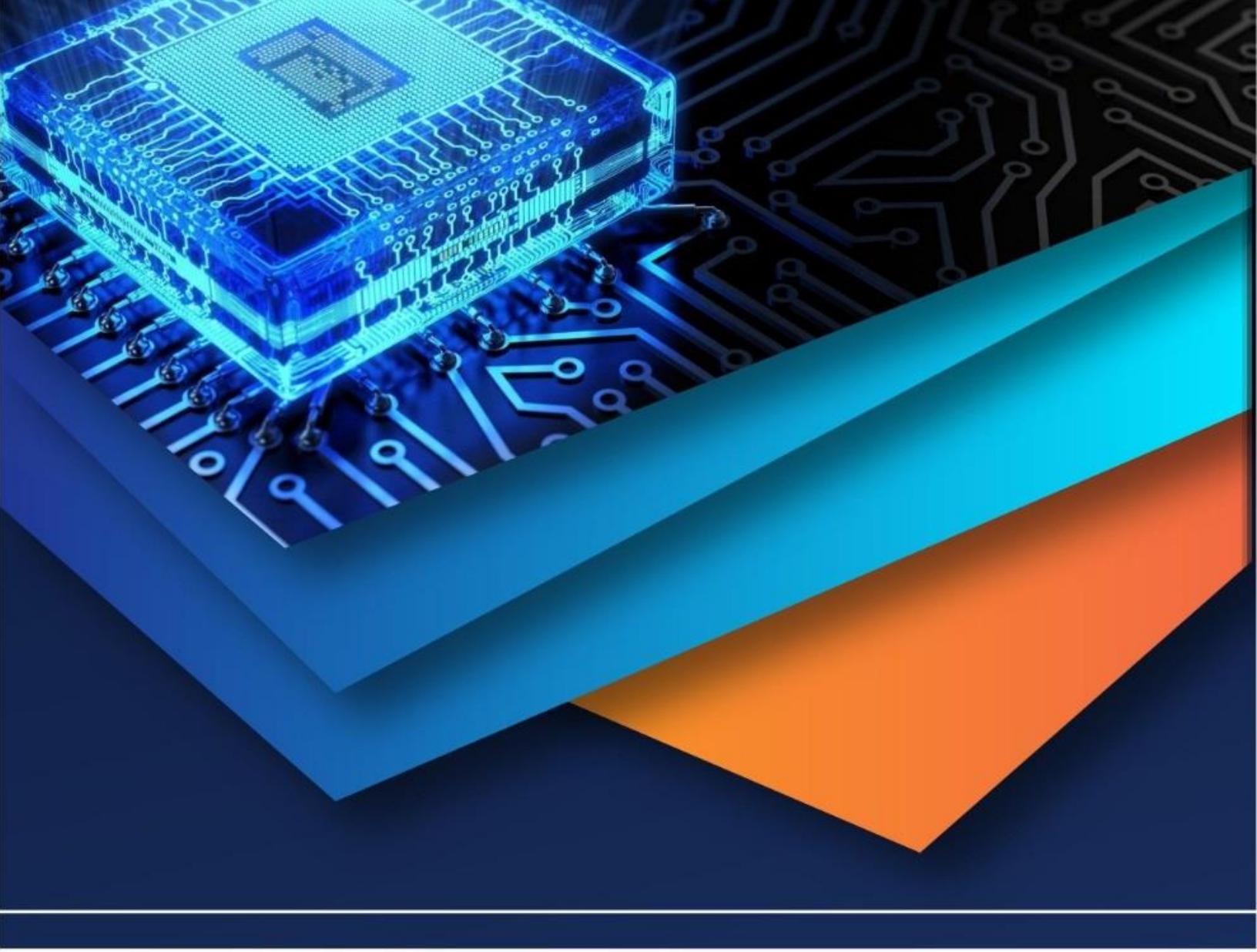
4) Smart Sensor Integration (Long-Term): The inclusion of vital sign sensors, pressure mapping, or proximity alerts could further elevate safety and monitoring, providing real-time data for caregivers or integration with telemedicine platforms.

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